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APPLICANT : HITACHI PLANT ENG & CONSTR CO LTD;

INVENTOR : YAMADERA TOSHIO;

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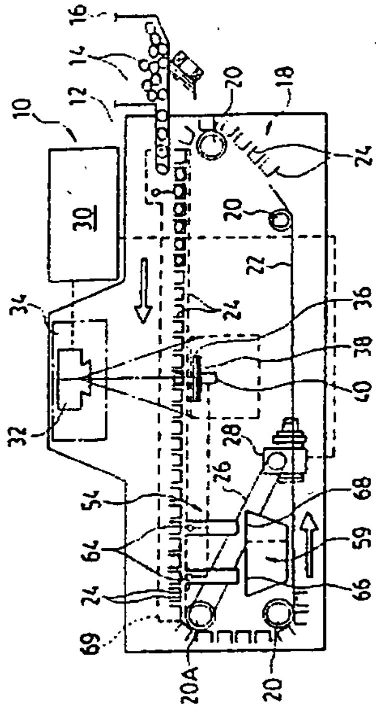
TITLE : METHOD FOR DETECTING RESIDUAL SHELL IN SHUCKED SHELLFISH AND APPARATUS THEREFOR



ABSTRACT : PURPOSE: To contrive automatic discrimination between pieces of shells and shucked shellfishes, by measuring intensity and wave form of an absorption part and absorption width of an absorption signal in an X-ray image and discriminating the X-ray absorption parts due to the pieces of the shell and shucked shellfishes based on the measured values.

CONSTITUTION: X-rays are irradiated to shucked shellfishes 14 in the respective buckets 24 on a bucket conveyor 18 in an X-ray irradiator 32. An X-ray image of the shucked shellfishes 14 is received by an X-fluorescent plate 36 emitting light by sensitizing to the X-rays of a receptor having the fluorescent plate 36. Further, the light emitted from the fluorescent plate 36 is converted into an electric signal by a photoelectric transfer element 38. The electric signal of the photoelectric transfer element 38 is amplified to a prescribed level in a signal processor 40 and then subjected to logarithmic conversion to measure the intensity, width and absorption wave form of an X-ray image absorption part of the above-mentioned transferred image signal. Thereby, X-ray image absorption parts of the shucked shellfishes and pieces of shells are discriminated based on the afore-mentioned measured values. Furthermore, a control signal is taken from the processor 40 in a selector 59 to operate the bucket 24 and remove the shucked shellfishes containing pieces of shells.

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(71)Applicant : HITACHI PLANT ENG & CONSTR CO LTD
(72)Inventor : HAYATA FUMITAKA
FUKUZAWA KUNIYUKI
KOIDE HIDEO
MATSUMOTO ATSUYUKI
YAMADERA TOSHIO

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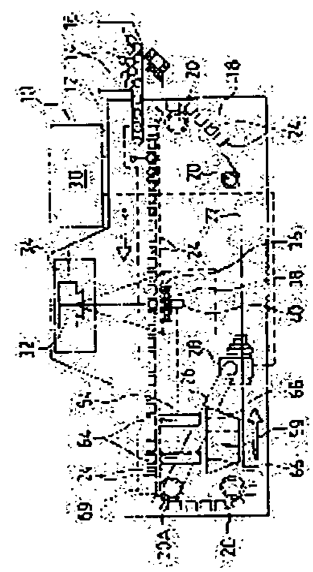

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審査請求　未請求　請求項の数 2　（全10頁）

⑭発明の名称　剝身貝中の残殻検出方法及び装置

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⑫発明者　早田　文隆　東京都千代田区内神田1丁目1番14号　日立プラント建設株式会社内
⑫発明者　福沢　邦之　東京都千代田区内神田1丁目1番14号　日立プラント建設株式会社内
⑫発明者　小出　英夫　東京都千代田区内神田1丁目1番14号　日立プラント建設株式会社内
⑪出願人　日立プラント建設株式会社　東京都千代田区内神田1丁目1番14号
⑭代理人　弁理士　松浦　憲三

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明　細　書

1．発明の名称

剝身貝中の残殻検出方法及び装置

2．特許請求の範囲

(1)剝身貝類中に残存する貝殻片を検出する剝身貝中の残殻検出方法に於いて、

剝身貝にX線を照射し、

前記剝身貝のX線画像をX線蛍光板を介して受光して電気信号に変え、

前記電気信号を所定のレベルに増幅した後に対数変換し、

対数変換したX線画像信号のX線画像吸収部の強度、幅、及び吸収波形を計測し、該計測値に基づいて剝身貝のX線画像吸収部と貝殻片のX線画像吸収部とを判別し、該判別に基づいて選別装置を制御して貝殻片を含む剝身貝を分離除去することを特徴とした剝身貝中の残殻検出方法。

(2)剝身貝類中に残存する貝殻片を検出する剝身貝中の残殻検出装置に於いて、

バケットが並設され、該バケットを一定の周期で間欠移送すると共に剝身貝が各バケットに所定量連続投入されるバケットコンベアと、

前記バケット内の剝身貝に向けてX線を照射するX線照射装置と、

X線に感光して発光するX線蛍光板を有し、該蛍光板で前記剝身貝のX線映像を受光する受光装置と、

前記受光装置のX線蛍光板の発光を電気信号に変換する光電変換素子と、

前記光電変換素子の電気信号を所定のレベルに増幅した後に対数変換して、該変換画像信号のX線画像吸収部の強度、幅、及び吸収波形を計測し、該計測値に基づいて剝身貝のX線画像吸収部と貝殻片のX線画像吸収部とを判別する信号処理装置と、

前記信号処理装置から前記判別に基づく制御信号を取り込み、前記コンベアのバケットを操作して貝殻片を含む剝身貝を分離除去する選別装置とから構成したこと特徴とした剝身貝中の残殻検出

装置。

3．発明の詳細な説明

〔産業上の利用分野〕

本発明は剝身貝中の残殻検出方法及び装置に係り、特に剝身貝中に残存する貝殻片或いは異物を検出する剝身貝中の残殻検出方法及び装置に関する。

〔従来技術〕

剝身貝類中の残殻の検出には、貝類をボイリングした後に剝身にし、煮熟汁を分離した後水槽に投入して粗大残殻を分離した後、次に、小さな残殻をメッシュ式コンベア上で目視検査してその分離除去を行っている。

第15図は従来の目視検査による剝身あさり中の残殻の検出方法を示す説明図である。第15図に示すようにボイリング後のあさりは階段状に形成された水槽70、70…内に順次投入及び移行され、粗大な残殻を分離した後、メッシュ式ベルトコンベア72に送られる。ベルトコンベア72上では検査員の目視検査によって剝身あさり中の残殻の検出がされ、また次の行程においては、サーチコイル式の金属探知機74で金属異物等が自動検出される。しかし、このような目視検査では、剝身内に突き刺さったり或いはあさり肉内に巻込まれた状態の残殻の目視確認はできず、又検査員の疲労が増大すると、見落としが多くなる虞がある。更に、メッシュ式ベルトコンベア72上に於いてあさりは空気中にさらされるため、その呈味が低下する虞がある。そこでこのような目視検査によるあさりの残殻検出方法に対して、機器による自動検出方法が考えられており、機器検出方式としては、超音波検出方式、電磁検査方式、軟X線方式がある。

〔発明が解決しようとする問題点〕

しかしながら、このような自動検出方法においては種々の問題がある。超音波検出方式はあさりと残殻の区別が容易に出来ない不具合がある。電磁検査方式は金属以外の異物検出が難しく、例えば非磁性金属は検出精度であるN／Sが悪いため、適用が困難となっている。

また、軟X線検査装置は各種の異物の認識ができるので、貝類以外の食品の異物検出に大きな実績がある。しかし、メッシュ式ベルトコンベア上に搬送されるあさりのX線テレビカメラの映像を目視判定する装置はなく、その判定の自動化が遅れている。この理由としては残殻と剝身あさりのX線吸収差が大きくないため、その信号処理が難しいこと及び残殻と剝身あさりの分離の有効な方法がないことによるものである。

本発明はこのような事情に鑑みてされたもので、残殻と剝身あさりのX線吸収差の検出感度を信号処理によって高め、自動判別ができる剝身中の残殻検出方法及び装置を提案することを目的としている。

〔問題点を解決するための手段〕

本発明は前記目的を達成するために、剝身貝類中に残存する貝殻片を検出する剝身貝中の残殻検出方法に於いて、剝身貝にX線を照射し、前記剝身貝のX線画像をX線蛍光板を介して受光して電気信号に変え、前記電気信号を所定のレベルに増幅した後に対数変換し、対数変換したX線画像信号のX線画像吸収部の強度、幅、及び吸収波形を計測し、該計測値に基づいて剝身貝のX線画像吸収部と貝殻片のX線画像吸収部とを判別し、該判別に基づいて選別装置を制御して貝殻片を含む剝身貝を分離除去することを特徴としている。

又、本発明によれば、剝身貝類中に残存する貝殻片を検出する剝身貝中の残殻検出装置に於いて、バケットが並設され、該バケットを一定の周期で間欠移送すると共に剝身貝が各バケットに所定量連続投入されるバケットコンベアと、前記バケット内の剝身貝に向けてX線を照射するX線照射装置と、X線に感光して発光するX線蛍光板を有し、該蛍光板で前記剝身貝のX線映像を受光する受光装置と、前記受光装置のX線蛍光板の発光を電気信号に変換する光電変換素子と、前記光電変換素子の電気信号を所定のレベルに増幅した後に対数変換して、該変換画像信号のX線画像吸収部の強度、幅、及び吸収波形を計測し、該計測値に基づいて剝身貝のX線画像吸収部と貝殻片のX線画像

吸収部とを判別する信号処理装置と、前記信号処理装置から前記判別に基づく制御信号を取り込み、前記コンベアのバケットを操作して貝殻片を含む剥身貝を分離除去する選別装置とから構成したことを特徴とする。

〔作用〕

本発明に係る剥身貝中の残殻検出方法及び装置によれば貝殻片と剥身あさりのX線透過像は高感度のX線蛍光板で捕らえられ、その発光を光電変換素子で電気的に変換され、信号処理装置によって電気信号を所定レベルまで増幅し、増幅に伴うノイズ及び信号本来の量子ノイズの除去のためにその信号は対数変換処理される。このように信号処理された貝殻片と剥身あさりのX線画像吸収部の判別には、平均ベースレベルからの吸収部の強度を求めること、吸収部の一定値での幅を求めること及び吸収波形を求めることによって行われる。このため、貝殻片と剥身貝との自動判別が出来、選別装置は判別信号に基づいて貝殻片を正確に選別することができる。

〔実施例〕

以下添付図面に従って本発明に係る剥身貝中の残殻検出方法及び装置の好ましい実施例を詳説する。

第1図は本発明に係る剥身貝中の残殻検出装置の説明図である。第1図及び第2図に示すように剥身貝中の残殻検出装置10の本体12の右側面には剥身あさり14の供給ホッパ16が設けられる。本体12内にはコンベア18が設けられ、コンベア18は複数のローラ20、20…と、各ローラ20間を周回するチェーン22と、チェーン22にピアノの鍵盤式に取付けられるバケット24、24…と、駆動ローラ20Aをベルト26を介して回転させるモータ28とから構成される。このモータ28は電源・制御ボックス30に接続され間欠回転される。従って、バケット24は間欠移送され、ホッパ16から供給される剥身あさり14はバケット24に所定量投入されて間欠移送される。

剥身貝中の残殻検出装置10の本体12の略中央の天井面には、X線照射装置32が取付けられ、X線照射装置32はシールドルーム34に収納されている。このX線照射装置32は電源・制御ボックス30に接続され、バケット24内の搬送剥身あさり14に向けて低X線強度（60～80KV、3～5mA）で照射している。又、このX線のリップル周波数は300Hzである。

第3図に示すように剥身あさり14を透過したX線は受光装置のX線蛍光板36によって受光される。X線蛍光板36は希土類系の蛍光体で形成され、その蛍光体の両面にDC350Vの電圧が印加される。このX線蛍光板36はX線画像を高感度且つ高輝度にエレクトロルミネッセンス表示できる特性を有している。又、この時、X線照射装置32のリップル周波数に同期させてX線蛍光板36の電圧の蓄積時間を設定している。これにより、X線蛍光板36はX線の周期変動を丸め込み、積分蓄積によるS／Nを向上させている。

X線蛍光板36には、X線蛍光板36での発光を電気信号に光電変換する光電変換素子38が密着され、光電変換素子38は密着系イメージセンサー（35画素、フォトダイオードアレイ）から成り、この電気信号は信号処理装置40にサンプリングされる。

信号処理装置40のパルスジェネレータ42はクロック信号及び取り込み開始信号をコントローラ44に出力する（第4図の(1)、(2)を参照）。コントローラ44は、開始信号に基づいてドライバー46に信号を出力し、ドライバー46はアドレス信号及び制御信号をマルチプレクサ48に出力する。光電変換素子40からの電気信号は、信号処理装置40内のマチプレクサ42によって照射X線のリップル周波数（300Hz）に同期させてサンプリングが開始されると共に光電変換素子38の一次元配列体から順次スイッチングされて読み取られる（第4図の(3)、(4)を参照）。これにより、信号処理部42内では約20mV程度のX線画像吸収レベル信号Aが得られる。

このX線吸収レベル信号Aは信号処理装置40内のビデオオペアンプ50によって10倍に増幅

され、A／D変換器52に出力される。A／D変換器52はコントローラ44からのトリガ信号に基づいて入力ビデオ信号をサンプルアンドホールド処理し、局所連続信号に変換して、12ビットA／D変換器52でデジタル信号に変換している。この場合、光電変換素子40の一次元配列体から読み出されたX線画像電気信号のスイッチングノイズを除去するため、電気信号のA／D変換は一次元配列体の光電変換素子40の読み出しクロック（100KHz）のタイミングとコントローラ44を介して同期される（第4図に示す(7)を参照）。これにより、増幅に伴うノイズ及び信号本来の量子ノイズの除去が有効に行われ、剝身あさりと残殻等のX線吸収差が小さくても、後の信号判別処理が容易となる。

次に、A／D変換器52からの信号はDMAインタフェイス54を介してデータ処理用の16ビットパーソナルコンピュータ56に送られる。

第5図（A）乃至（D）は、パーソナルコンピュータ56によって原信号を補正処理した種々の段階でのCRT画像図である。

第5図（A）はA／D変換器52からの原信号に基づくCRT画面によるX線画像吸収波形図であり、第5図（B）は原信号を対数変換補正（ie log V）したCRT画面によるX線画像吸収波形図である。第5図（C）は対数変換信号をゲイン補正したCRT画面によるX線画像吸収波形図であり、第5図（D）はゲイン補正した信号を更にシェージング補正したCRT画面によるX線画像吸収波形図である。パーソナルコンピュータ56は第5図（D）のシェージング補正された信号に基づいてX線画像吸収波形のトラップ（X線吸収部）の解析を行う（第6図参照）。コンピュータ56はX線吸収の平均ベースレベルからのトラップの深さ（X線吸収強度）、平均ベースレベルから一定値下がった値でのトラップの幅、トラップの波形及びトラップの積分値（面積値）を計測し、その計測値に基づいて剝身あさりによるトラップと残殻又はその他の異物によるトラップ等を判別処理し、その判別処理に基づく制御信号を第1図及び第2図に示すように後段の選別装置59に出力している。

第7図及び第8図に示すようにコンベア18のチェーン22にはアーム60が取付けられ、アーム60の先端には枢支ピン62を介してバケット24の一端が回動可能に取付けられる。バケット24の他端は支持ローラ64によって支持される。

選別装置59における支持ローラ64は第8図に示すように矢印Aの方向に移動可能になっており、この移動によってバケット24が下方に回動されてバケット24内の剝身あさり14は落下される。この選別装置59の支持ローラ64、64…の下方位置には、第1図に示すように良品用ホッパ66及び不良品用ホッパ68が設けられる。従って、選別装置59の支持ローラ64、64…が操作されることによって、バケット24中の剝身あさり14は、バケット24が下方に回動して良品用ホッパ66或いは不良品用ホッパ68に落下される。

選別装置59の支持ローラ64、64…は、信号処理装置40のコンピュータ56の制御信号に基づいて作動され、残殻又は異物のあるバケット24が不良品ホッパ68上方の支持ローラ64に位置したとき、その支持ローラ64が制御信号によって第8図に示す矢印Aの方向に移動する。又、異物等が残存しない剝身あさり14のバケット24は良品ホッパ66の上方の支持ローラ66に位置したときにその支持ローラ66が第8図に示す矢印Aの方向に移動する。

尚、剝身あさり14中の残殻検出装置の本体12内のバケットコンベア18の検査領域内は遮蔽ボックス69が形成され、ボックス69によってX線の外部拡散を防止している。

前記の如く構成された本発明に係る剝身貝中の残殻検出方法及び装置によれば、供給ホッパ16から投入された剝身あさり14はバケット24に所定量づつ連続投入され、X線照射装置32の下に間欠移送される。バケット24中の剝身あさり14は、X線照射装置32によってコンベア18

の間欠移送周期と同期してＸ線が照射される。剝身あさりのＸ線透過画像はＸ線蛍光板３６によって受光される。Ｘ線蛍光板３６の発光は光電変換素子３８によって電気信号に変換され、電気信号は信号処理装置４０に取り込まれる。

信号処理装置４０は光電変換素子３８からの電気信号を一定のタイミングで取り込み、Ｘ線画像レベル信号Ａをオペアンプ５０で増幅し、Ａ／Ｄ変換器５２でデジタル変換している。デジタル信号にしたＸ線画像処理信号はパーソナルコンピュータ５６に出力され、パーソナルコンピュータ５６はＸ線画像処理信号を対数変換補正処理し、オペアンプ５０及びＡ／Ｄ変換器５２の増幅に伴うノイズ及び信号本来の量子ノイズの除去を行っている。これにより、補正されたＸ線画像信号は剝身あさり１４及び残殻に対して明確な吸収部を示す。

第９図（Ａ）乃至第１２図（Ａ）は剝身あさり及び残殻の撮影時の状態を示す側面図、第９図（Ｂ）乃至第１２図（Ｂ）はその時のＸ線映像信号を示したＸ線吸収波形図である。Ｘ線波形吸収画像図は対数変換処理補正以外にゲイン補正及びシェージング補正がされている。第９図乃至第１２図から明らかなように、剝身あさり１４及び残殻１５のトラップが明確に検出され、そのＸ線吸収値はコンピュータ５６からプリンタすることができる。又、これらの検出トラップは、その深さ（Ｘ線吸収強度）、その幅、その波形及びトラップの総面積が計測され、その計測に基づいて剝身あさり１４によるトラップと残殻１５又はその他の異物によるトラップとを判別処理している。このため、剝身１４あさりと、残殻１５の判別が明確にされ、自動判別することができる。

そして、パーソナルコンピュータ５６の判別処理に基づく制御信号が選別装置５９に出力され、選別装置５９はこの制御信号に基づいて、貝殻片或いは異物を含んだコンベア２４は支持ローラ６４の操作によって鍵盤式に回動ダウンされ、残殻或いは異物を含む剝身あさり１４は、容易に不良ホッパ６８に集積して分離できる。従って、Ｘ線を用いた検出方法により剝身あさり１４中の残存する残殻を自動的に検出及び分離することができる。

第１３図及び第１４図は本発明に係る剝身貝中の残殻検出方法及び装置の第２実施例の平面図及び側面図である。第１３図及び第１４図に示すように、剝身貝中の残殻検出方法及び装置７１の供給ホッパ１６、Ｘ線照射装置３２、Ｘ線蛍光板３６及び信号処理装置４０は第１図の第１実施例の装置と略同様な構造になっており、その詳しい説明は省略する。

第２実施例における剝身貝中の残殻検出装置７１においては、バケットコンベア７３に特徴があり、バケットコンベア７３の回転板７５の周囲には略扇状のバケット７７、７７…が配せられ、その一端は回動可能に枢支され、バケット７７、７７…の外側の他端には支持ローラ６４、６４…が配せられる。回転板７５はモータ２８によって間欠回転され、それと共にバケット７７も間欠移送される。又、選別装置５９の支持ローラ６４は信号処理装置４０からの制御信号に基づいて回転板７５の外方向（第１３図に示す矢印Ｅ又はＦ）に移動操作され、バケット７７が下方に回動するようになっている。

このような構造においても、第１図及び第２図で示した剝身貝中の残殻検出方法及び装置と同様に、貝殻片及び異物を含む剝身あさり１４のバケット７７を容易に操作することができ、その分離が簡単にできる。

〔発明の効果〕

以上説明したように本発明に係る剝身貝中の残殻検出方法及び装置によれば、Ｘ線透過像は光電変換素子で電気信号に変換され、信号処理装置によってそのＸ線画像レベル信号が所定のレベルまで増幅され、対数変換処理補正がなされ、Ｘ線画像吸収波形信号の吸収部の強度、吸収幅及び吸収部の波形状を計測し、この計測値に基づいて貝殻片のＸ線吸収部と剝身貝のＸ線吸収部を判別するようにしたので、貝殻片と剝身貝のＸ線吸収差の検出感度を高め、自動判別することができる。

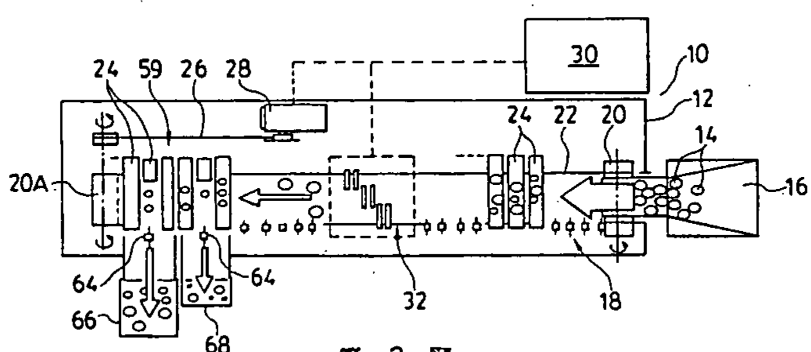
4．図面の簡単な説明

第１図は本発明に係る剥身貝中の残殻検出装置第２図は第１図の側面図、第３図は本発明に係る剥身貝中の残殻検出装置の信号処理装置の説明図、第４図は信号処理装置内のタイミング図、第５図はパーソナルコンピュータによって原信号を補正処理した時の種々の段階でのＣＲＴ画像によるＸ線画像吸収波形図、第６図はパーソナルコンピュータで判別を行うＸ線画像吸収波形図、第７図及び第８図はバケットの取付構造を示す側面図、第９図乃至第１２図は剥身貝及び貝殻片の撮影時を示す側面図及びその時のＸ線画像吸収波形図で、第９図（Ａ）乃至第１２図（Ａ）は撮影時の側面図、第９図（Ｂ）乃至第１２図（Ｂ）はＸ線画像吸収波形図、第１３図及び第１４図は本発明に係る剥身貝中の残殻検出装置の第２実施例の平面図及び側面図、第１５図は従来の剥身貝中の残殻検出方法の説明図である。

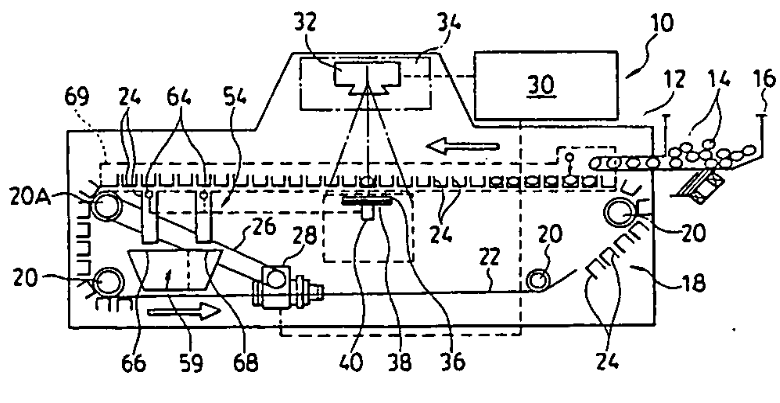
１０、７１…剥身貝中の残殻検出方法及び装置、１２…本体、１４…剥身あさり、１５…残殻、１８、７３…バケットコンベア、２０…ローラ、２２…チェーン、２４、６８…バケット、２８…モータ、３２…Ｘ線照射装置、３６…Ｘ線蛍光板、３８…光電変換素子、４０…信号処理装置、４２…パルスジェネレータ、４４…コントローラ、４８…マルチプレクサ、５０…ビデオオペアンプ、５２…Ａ／Ｄ変換器、５６…パーソナルコンピュータ、５９…選別装置、６４…支持ローラ、６６…良品ホッパ、６８…不良品ホッパ。

代理人　弁理士　松浦憲三

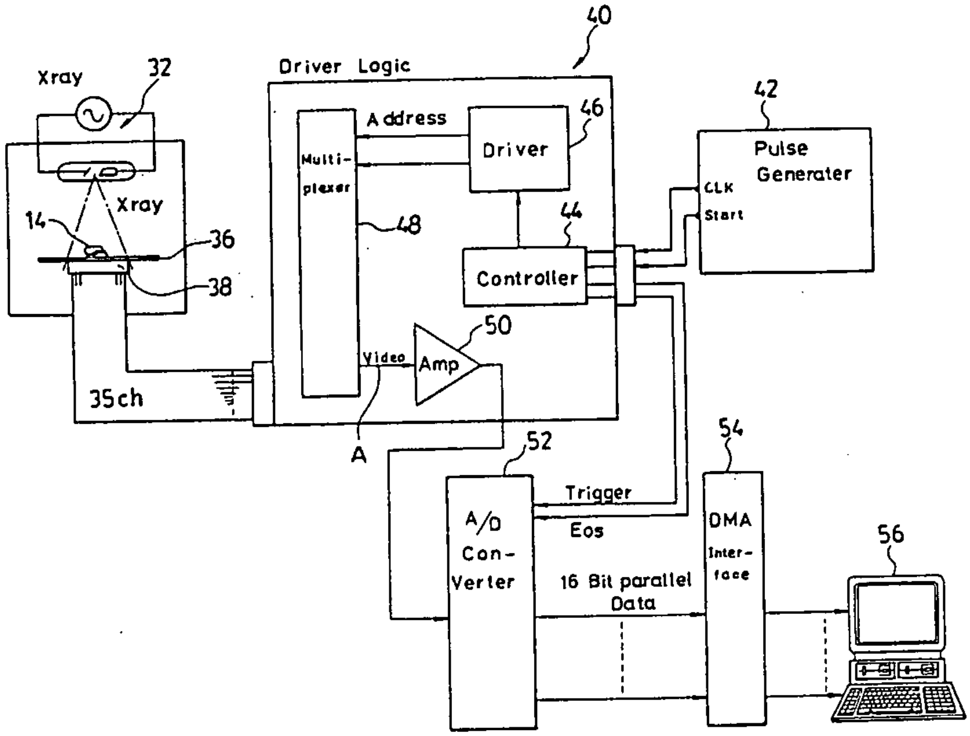
第１図



第２図



第3図



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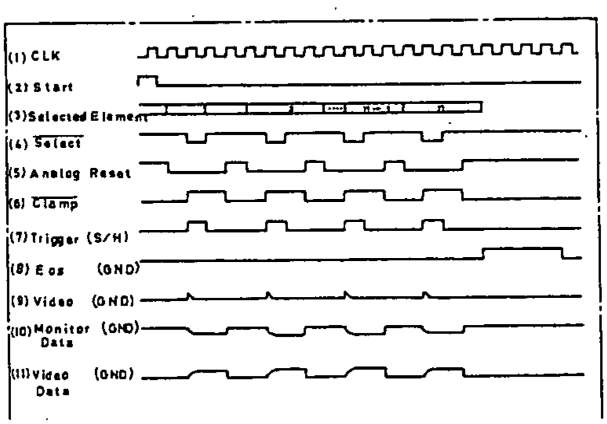

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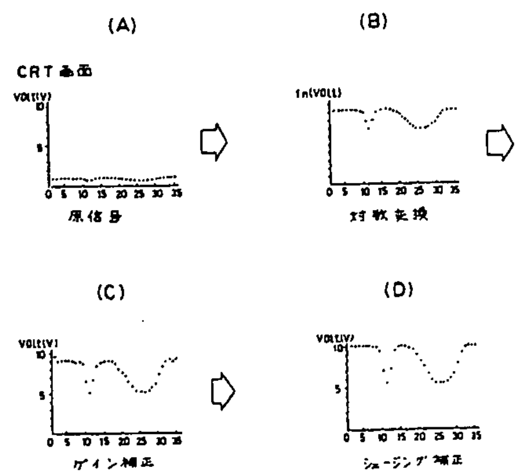

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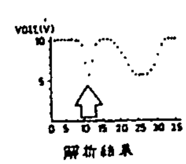

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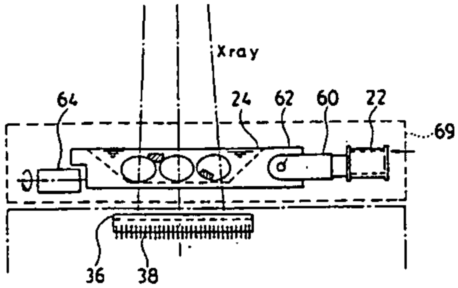

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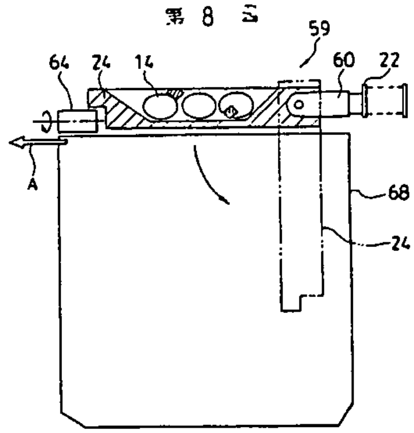

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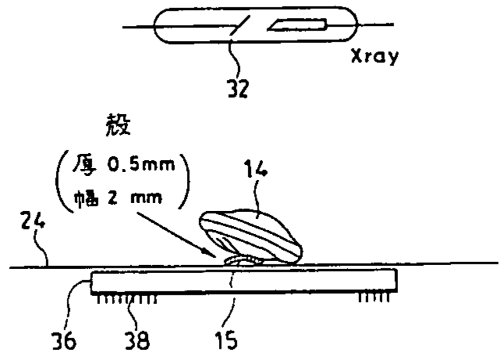
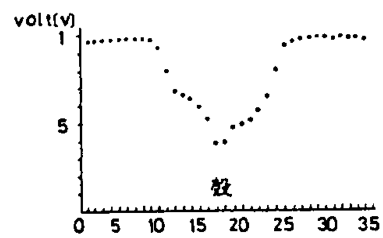


(B)



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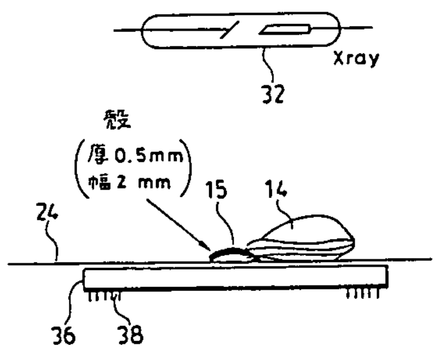

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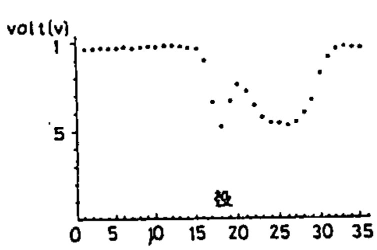

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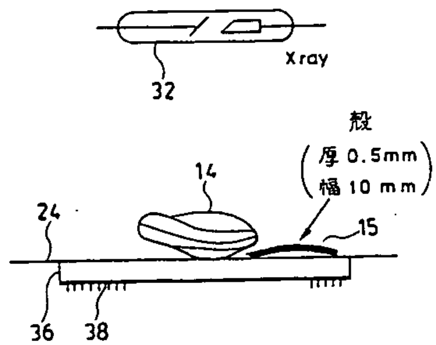

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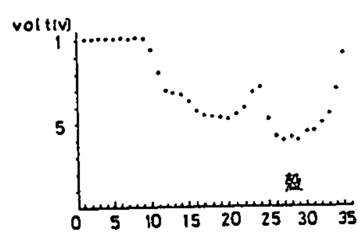
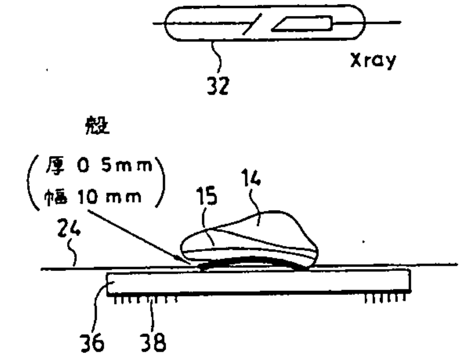


第 12 図

(A)



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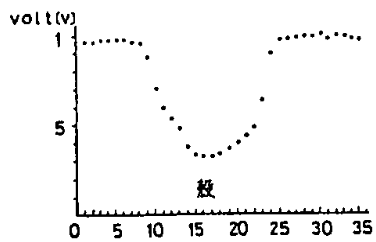

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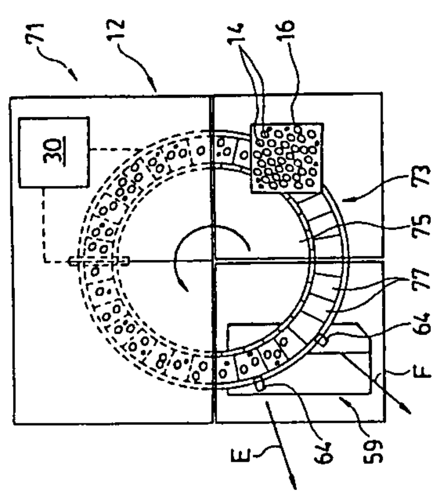
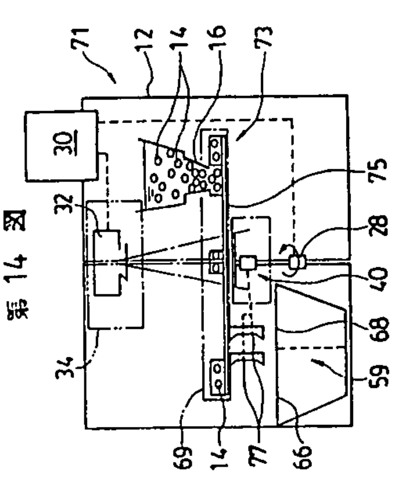
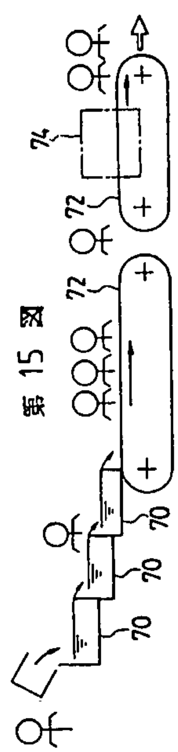


第 14 図



第 15 図



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第1頁の続き
⑫発 明 者　松 本　篤 幸　東京都千代田区内神田1丁目1番14号　日立プラント建設株式会社内
⑫発 明 者　山 寺　利 夫　東京都千代田区内神田1丁目1番14号　日立プラント建設株式会社内

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DETECTING METHOD AND DEVICE FOR REMAINS SHELL IN SHUCKED SHELLFISH

(Mukizikai chu no Zangara Kenshutsu Hoho oyobi Sochi)

Fumitaka Hayata, Kuniyuki Fukuzawa, Hideo Koide

Atsuyuki Matsumoto and Toshio Yamadera

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SPECIFICATION

/1[1]

I. Title of the Invention

Detecting Method and Device for Remains Shell in Shucked Shellfish

II. Claims

1. A detecting method for remains shell in a shucked shellfish which detects shell pieces remaining in the shucked shellfish is characterized by that

an X-ray is irradiated to a shucked shellfish,

an X-ray image of said shucked shellfish is received via an X-fluorescent plate and is converted to an electric signal,

the said electric signal is amplified to a prescribed level and then subjected to a logarithmic transformation,

the intensity, width and absorption wave form of X-ray image of X-ray image absorption parts given by the logarithmic transformation are measured, the X-ray image absorption part of said shucked shellfish and the X-ray image absorption part of said shell pieces are discriminated based on the said measured values, and a sorting unit is controlled to separate and remove the shucked shellfish containing the shell pieces based on said discrimination.

[1] Numbers in the margin indicate pagination in the foreign text.

2. A detecting device for remains shell in a shucked shellfish which detects shell pieces remaining in the shucked shellfish is characterized by comprising

a bucket conveyer in which buckets are arranged side by side, said buckets are transferred intermittently at a given period and a prescribed quantity of shucked shellfish is continuously charged to the respective buckets ,

an X-ray irradiation unit which irradiates an X-ray to the shucked shellfish in the said buckets,

a light receiver which has an X-fluorescent plate for sensitizing to the X-ray and emitting a light and receives an X-ray image of said shucked shellfish by said fluorescent plate,

a photoelectric transfer element which converts a light emitted from the X-fluorescent plate of said light receiver,

a signal processing unit which amplifies the electric signal of said photoelectric transfer element to a prescribed level and then processes it by logarithmic transformation, measures the intensity, width and absorption wave form of X-ray image absorption parts given by the logarithmic transformation, and discriminates the X-ray image absorption part of said shucked shellfish and the X-ray image absorption part of said shell pieces based on said measured values, and

a sorting unit which intakes a control signal from said signal processing unit based on said discrimination and operates the

buckets of said conveyer to separate and remove the shucked shellfish containing shell pieces.

/2

III. Detailed Description of the Invention

[Field of Industrial Application]

This invention relates to a detecting method and a detecting device for remains shell in a shucked shellfish, and particularly to a detecting method and a detecting device for detecting shell pieces or foreign matters remaining in a shucked shellfish.

[Prior Art]

For the detection of remains shell in a shucked shellfish, a shellfish is boiled and then shucked, after a boiled stock is separated, put into a water tank to separate a coarse remains shell, then small remains shell is separated and removed on a mesh type conveyer by visual inspection.

Fig. 15 is an illustrative diagram showing a conventional detecting method of remains shell in a shucked shellfish by visual inspection. As shown in Fig. 15, a short-necked clam after boiling is charged and carried sequentially into water tanks **70, 70** … formed stepwise and, after a coarse shell is separated, delivered by mesh belt conveyers **72**. On the belt conveyers **72**, remains shell in the shucked short-necked clam is detected by visual inspection of inspectors and then metal foreign matters are automatically detected by a search coil type metal detector **74** in the next

process step.

In such a visual inspection, however, it is feared that the visual confirmation of remains shell cannot be made in a state of sticking the shucked shellfish or winding into the meat of shucked short-necked clam or the overlook of inspectors increases if their fatigue increases. Moreover, it is feared that the taste of the shucked short-necked clam deteriorates because it is exposed to air on the mesh belt conveyers **72**. Accordingly, an automatic detecting methods by machines are considered, an ultrasonic inspection mode, an electromagnetic inspection mode and a soft X-ray inspection mode are given as machine detection modes.

[Problems to Be Solved by the Invention]

However, various problems exist in devices applied with such an automatic inspection modes. In the ultrasonic inspection mode, there is an inconvenience that the shucked short-necked clam and the remains shell cannot be easily discriminated. In the electromagnetic inspection mode, the inspection of foreign matters other than metals is difficult, for example, the application to non-magnetic metals becomes difficult because the N/S being the detection accuracy is bad.

Because soft X-ray inspection unit can recognize various foreign matters, it gives great results in foreign matter detection of food other than shellfish. However, this is not a unit for visually judging an image of X-ray TV camera of said shucked

shellfish conveyed on the mesh type belt conveyer, thus the automation of this judgement is retarded. The reason for it is that the X-ray absorption difference between the remains shell and the shucked shellfish is not big, therefore the signal processing is difficult and there is no effective method for the separation of the remains shell and the shucked shellfish.

This invention was made in view of such a circumstance and is aimed at providing a detecting method and a detecting device for remains shell in a shucked shellfish which enables to enhance the detection sensitivity of X-ray absorption difference between the remains shell and the shucked short-necked clam by signal processing.

[Means for Solving the Problem]

To achieve the said purpose, a detecting method for remains shell in a shucked shellfish which detects shell pieces remaining in the shucked shellfish is characterized by that

an X-ray is irradiated to a shucked shellfish, an X-ray image of said shucked shellfish is received via an X-fluorescent plate and is converted to an electric signal, the said electric signal is amplified to a prescribed level and then subjected to a logarithmic transformation, the intensity, width and absorption wave form of X-ray image of X-ray image absorption parts given by the logarithmic trans-formation are measured, the X-ray image absorption part of said shucked shellfish and the X-ray image absorption part of said

shell pieces are discriminated based on the said measured values, and a sorting unit is controlled to separate and remove the shucked shellfish containing the shell pieces based on said discrimination.

According to this invention, a detecting device for remains shell in a shucked shellfish which detects shell pieces remaining in the shucked shellfish is characterized by comprising

a bucket conveyer in which buckets are arranged side by side, said buckets are transferred intermittently at a given period and a prescribed quantity of shucked shellfish is continuously charged to the respective buckets, an X-ray irradiation unit which irradiates an X-ray to the shucked shellfish in the said buckets, a light receiver which has an X-fluorescent plate for sensitizing to the X-ray and emitting a light and receives an X-ray image of said shucked shellfish by said fluorescent plate, a photoelectric transfer element which converts a light emitted from the X-fluorescent plate of said light receiver, a signal processing unit which amplifies the electric signal of said photoelectric transfer element to a prescribed level and then processes it by logarithmic transformation, measures the intensity, width and absorption wave form of X-ray image absorption parts given by the logarithmic transformation, and discriminates the X-ray image absorption part of said shucked shellfish and the X-ray image absorption part of said shell pieces based on said measured values, and a sorting unit which intakes a control signal from said signal processing unit

based on said discrimination and operates the buckets of said conveyer to separate and remove the shucked shellfish containing shell pieces.

[Functions]

According to the detecting method and device for remains shell in a shucked shellfish relating to this invention, the X-ray transmitted images of shell pieces and shucked short-necked clam are captured by a high-sensitivity X-fluorescent plate, this emitted light is converted electrically by the photoelectric transfer element, the electric signal is amplified to a prescribed level by the signal processing unit, and then this signal is processed by logarithmic transformation for removal of noises associated with the amplification and original quantum noises of the signal. The discrimination of the X-ray image absorption parts of said shell pieces and shucked short-necked clam which are signal processed in this way is performed by evaluating the intensity of absorption parts from a mean base level, the width of absorption parts at a given value as well as the absorption wave form. Therefore, this invention can make an automatic discrimination of the shell pieces and the shucked short-necked clam, and the sorting unit can correctly sort the shell pieces based on the discrimination signal.

[Actual Examples]

Preferable actual examples of the detecting method and device

for remains shell in a shucked shellfish relating to this invention will be illustrated in detail according to attached drawings below.

Fig. 1 is an illustrative diagram of the detecting device for remains shell in a shucked shellfish relating to this invention. As shown in Fig. 1 and Fig. 2, a feed hopper **16** of shucked short-necked clam is provided on the right side surface of a body **12** of said detecting device **10** for remains shell in the shucked shellfish. A conveyer **18′** is provided in the body **12**, and the conveyer **18** comprises multiple rollers **20, 20** …, a chain **22** around the rollers **20**, buckets **24, 24** mounted to the chain **22** by a piano keyboard type and a motor **28** which drives a driving roller **20A** via a belt **26**. This motor **28** is connected to a power supply/control box **30** and intermittently rotated. Accordingly, the buckets **24** are intermittently transferred and the shucked short-necked clam is intermittently charged and transferred in a predetermined quantity by the buckets **24**.

An X-ray irradiation unit **32** is installed at about the central ceiling of body **12** of said detecting device **10** for remains shell in shucked shellfish and housed in a seal drum **34**. This X-ray irradiation unit **32** is connected to the power supply/control box **30** and irradiates to the carried shucked short-necked clam **14** in the buckets **24** at a low X-ray intensity (60 - 80 kV, 3 - 5 mA). Moreover, the ripple frequency of this X-ray is 300 Hz.

As shown in Fig. 3, the X-ray transmitting through the shucked short-necked clam **14** is received by an X-fluorescent plate **36** of a light receiver. The X-fluorescent plate **36** is formed with an rare-earth fluorophor, and a voltage of DC 350 V is applied to both sides of said fluorophor. This X-ray fluorescent plate **36** has a characteristic capable of displaying an X-ray image by electro-luminescence in a high sensitivity and a high brightness. At this time, the cumulative time of voltage of said X-fluorescent plate **36** is set up in synchronism with the ripple frequency of said X-ray irradiation unit **32**. This coaxes the periodic fluctuation of X-ray and enhances the S/N caused by the integral accumulation. A photoelectric transfer element **38** for photoelectrically converting the light emitted at the X-ray fluorescent plate **36** to an electric signal is closely adhered to the X-fluorescent plate **36** and consists of an adhesion image sensor (35 image elements, photodiode array), and this electric signal is sampled in a signal processing unit **40**.

A pulse generator **42** of said signal processing unit **40** outputs a clock signal and an intake start signal to a controller **44** (see (1), (2) of Fig. 4). The controller **44** outputs a signal to a driver **46** based on the start signal, and the driver **46** outputs an address signal and a control signal to a multiplexer **48**. The electric signal from the photoelectric transfer element **38** (wrong number **40**

in the original specification, translator) is read by starting the sampling and sequentially switching from a one-dimension array body of said photoelectric transfer element **38** in synchronism with the ripple frequency of X-ray (300 Hz) by the multiplexer **48** (wrong number **42** in the original specification, translator) (see (3), (4) of Fig. 4). This gives an X-ray image absorption level signal A of about 20 mV in the signal processing unit **40** (wrong number **42** in the original specification, translator).

This X-ray image absorption level signal A is amplified to 10 times by a video operation amplifier **50** in the signal processing

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unit **40** and then outputs to an A/D converter **52**. The A/D converter **52** processes the input video signal by a sample-and-hold circuit based on a trigger signal from the controller **44**, converts it to a local continuous signal and then converts the signal to a digital signal by the 12-bit A/D converter **52**. In this case, the A/D conversion of said electric signal is synchronized with the timing of clock (100 KHz) read by the one-dimension array body of said photoelectric transfer element **38** (wrong number **40** in the original specification, translator) via the controller **44** to remove switch noises of said X-ray image electric signal read from the one-dimension array body of said photoelectric transfer element **38** (wrong number **40** in the original specification, translator) (see

(7) of Fig. 4). This effectively removes the noises associated with the amplification and the original quantum noises of said signal and facilitates subsequent signal discrimination processing even if the X-ray absorption difference between the shucked short-necked clam and the remains shell is small.

Next, the signal from the A/D converter **52** is sent to a 16-bit personal computer **56** for data processing via a DMA interface **54**.

Fig. 5(A) to 5(D) are CRT image pictures in various steps wherein the original signal is corrected and processed by the personal computer **56**.

Fig. 5(A) is an X-ray image absorption wave form chart given by a CRT screen based on the original signal from the A/D converter **52**, and Fig. 5(B) is an X-ray image absorption wave form chart given by the CRT screen with an original signal corrected by logarithmic transformation (ielog V). Fig. 5(C) is an X-ray image absorption wave form chart given by the CRT screen with the logarithmic transformed signal which is corrected by gain, and Fig. 5(D) is an X-ray image absorption wave form chart given by the CRT screen with the gain corrected signal which is further corrected by shading. The personal computer **56** makes an analysis of traps (X-ray absorption parts) of an X-ray image absorption wave form of Fig. 5(D) based on the signal corrected by shading (see Fig. 6). The computer **56** measures the depth of traps (X-ray absorption intensity) from a mean base level of X-ray absorption, the width of trap

at a value going down for a given value from the mean base level, the wave form of traps and the integral quantity (area value) of traps, discriminates a trap caused by the shucked short-necked clam and a trap caused by the remains shell and other foreign matters, etc. based on these measured values, and then outputs a control signal to a subsequent sorting unit **59** based on this discrimination processing as shown in Fig. 1 and Fig. 2.

As shown in Fig. 7 and Fig. 8, an arm **60** is mounted to the chain **22** of said conveyer **18**, and one end of said buckets **24** is rotatably mounted to the front end of said arm **60** via a pivot pin **62**. The other end of said buckets **24** is supported by support rollers **64**.

The support rollers **64** in the sorting unit **59** are movable in the direction of arrow A as shown in Fig. 8, the buckets **24** are rotated downward to allow the shucked short-necked clam **14** in the buckets **24** to fall down by this movement. A non-defectives hopper **66** and a defectives hopper **68** are provided in a position below the support rollers **64, 64** … of said sorting unit **59**. Accordingly, the buckets **24** are rotated downward to allow the shucked short-necked clam **14** in the buckets **24** to fall down into the non-defectives hopper **66** or the defectives hopper **68** by operating the support rollers **64, 64** … of said sorting unit **59**.

The support rollers **64, 64** … of said sorting unit **59** are

operated based on the control signal of computer **56** of said signal processing unit **40,** when a bucket **24** having remains shell or foreign matters is located on the support rollers **64** above the defectives hopper **68,** these support rollers **64** move in a direction shown in Fig. 8 according to the control signal. When a bucket **24** having remains shell without remaining foreign matters is located on the support rollers **64** (wrong number **66** in the original specification) above the non-defectives hopper **66,** these support rollers **64** move in a direction shown in Fig. 8 according to the control signal.

Moreover, a shielding box **69** is formed in an inspection area of bucket conveyer **18** in the body **12** of said detecting device for remains shell in the shucked short-necked clam **14** to prevent the X-ray from external diffusion by the box **69.**

According to the detecting method and device for remains shell in shucked shellfish relating to this invention constituted as described above, a prescribed quantity of the shucked short-necked clam **14** charged form the feed hopper **16** is continuously charged and intermittently transferred below the X-ray irradiation unit **32.** An X-ray is irradiated to the shucked short-necked clam **14** by the X-

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ray irradiation unit **32** in synchronism with the intermittent transfer period. An X-ray transmitted image is received by the X-

ray fluorescent plate **36**. The light emitted from said X-ray fluorescent plate **36** is converted to an electric signal by the photoelectric transfer element **38**, and then the electric signal is taken into the signal processing unit **40**.

The signal processing unit **40** intakes the electric signal from the photoelectric transfer element **38** at a given timing, an X-ray image level signal A is amplified by the operation amplifier **50** and then digitally converted by the A/D converter **52**. The X-ray image processing signal A made to a digital signal is output to the personal computer **56** to correct and process the X-ray image processing signal A by logarithmic transformation, and then noises associated with the amplification of said operation amplifier **50** and said A/D converter **52** and original quantum noises of signal are removed. Thereby, the corrected X-ray image signal indicates clear absorption parts for the shucked short-necked clam **14** and the remains shell.

Fig. 9(A) to 12(A) are side views showing state in the photograph of said shucked short-necked clam **14** and said remains shell, and Fig. 9(B) to 12(B) are X-ray absorption wave form charts showing X-ray image signals at this time. The X-ray wave form absorption image pictures are corrected by gain and shading in addition to logarithmic transformation. As is evident from Fig. 9 to Fig. 12, the shucked short-necked clam **14** and the remains shell

15 are clearly detected, and their X-ray absorption values can be printed out from the computer **56**. The depth (X-ray absorption intensity), the width, the wave form of these detected traps and the total area of said traps are measured, then the traps caused by the shucked short-necked clam **14** and the traps caused by the remains shell **15** and other foreign matters are discriminated and processed based on these measured values. Therefore, the discrimination of said shucked short-necked clam **14** and said remains shell **15** can be confirmed and made automatically.

Then, a control signal is output to the sorting unit **59** based on the discrimination processing of said personal computer **56**, buckets **24** containing remains shell or foreign matters are rotated down by a keyboard type in the sorting unit **59** by operation of support rollers **64**, and the shucked short-necked clam **14** containing remains shell or foreign matters can be easily accumulated in the defectives hopper **68** and separated. Accordingly, the remains shell remaining in the shucked short-necked clam **14** can be automatically detected and separated by the detection method using an X-ray.

Fig. 13 and Fig. 14 are plan view and side view of Actual Example 2 of the detecting method and device for remains shell in shucked shellfish relating to this invention. As shown in Fig. 13 and Fig. 14, a feed hopper **16**, an X-ray irradiation unit **32**, an X-fluorescent plate **36** and a signal processing unit **40** in the

detecting method and device **71** for remains shell in shucked shellfish have about the same structure as Actual Example 1 of Fig. 1, and their detailed description is omitted.

The detecting device **71** for remains shell in shucked shellfish in Actual Example 2 is characterized by a bucket conveyer **73**, roughly fan-like buckets **77**, **77** … are arranged around a rotating plate **75** an a bucket conveyer **73**, the one end is rotatably pivoted , and support rollers **64**, **64** … are arranged at the other end of outer side of said buckets **77**, **77** …. The rotating plate **75** is intermittently rotated by a motor **28**, and the buckets **77** are also transferred therewith. Support rollers **64** of a sorting unit **59** are moved and operated in the outward direction (arrows E or F shown in Fig. 13) of said rotating plate **75** based on a control signal from the signal processing unit **40**, and the buckets **77** are rotated below it.

Similarly to the detecting method and device for remains shell in shucked shellfish shown in Fig. 1 and Fig. 2, the buckets **77** of said shucked short-necked clam **14** containing shell pieces and shucked short-necked clam can be easily operated and their separation can be simplified in such a structure.

[Effects of the Invention]

As described above, the detecting method and device for remains shell in shucked shellfish relating this invention enables

to enhance the detection sensitivity of X-ray absorption difference between shell pieces and shucked shellfish because an X-ray is irradiated to a shucked shellfish, an X-ray image of said shucked shellfish is received via an X-fluorescent plate and is converted to an electric signal, the X-ray image level signal is amplified to a prescribed level and then subjected to a logarithmic transformation, the intensity, width and absorption wave form of X-ray image absorption part given by the logarithmic transformation are measured, the X-ray image absorption part of said shucked shellfish and the X-ray image absorption part of said shell pieces are discriminated based on these measured values.

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IV. Brief Description of the Drawings

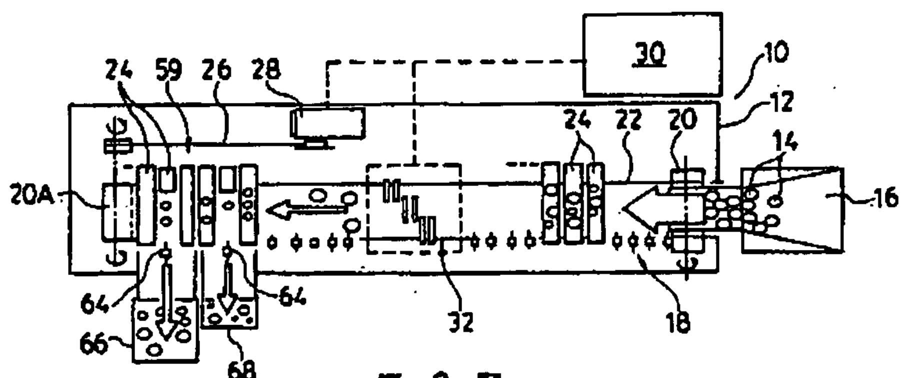
Fig. 1 is detecting device for remains shell in shucked shellfish relating to this invention, Fig. 2 is side view of Fig. 1, Fig. 3 is illustrative diagram of signal processing unit of detecting device for remains shell in shucked shellfish, Fig. 4 is timing chart in signal processing unit, Fig. 5 is X-ray image absorption wave form charts given by CRT in various steps at the time of correcting original signal by personal computer, Fig. 6 is X-ray image absorption wave form chart for discrimination by personal computer, Fig. 7 and Fig. 8 are side views showing mounting structure of buckets, Fig. 9 to Fig. 12 are side views showing shucked shellfish and shell pieces in photography and X-ray

image absorption wave form charts, Fig. 9(A) to Fig. 12(A) are side views in photography, Fig. 9(B) to Fig. 12(B) are X-ray image absorption wave form charts, Fig. 13 and Fig. 14 are plan views and side views of Actual Example 2 of detecting device for remains shell in shucked shellfish relating to this invention, and Fig. 15 is illustrative diagram of conventional detecting method for remains shell in shucked shellfish.

10, 71	…	detecting method and device for remains shell in shucked shellfish
12	…	body
14	…	shucked shellfish
15	…	remains shell
18, 73	…	bucket conveyers
20	…	roller
22	…	chain
24, 68	…	buckets
28	…	motor
32	…	X-ray irradiation unit
36	…	X-fluorescent plate
38	…	photoelectric transfer element
40	…	signal processing unit
42	…	pulse generator
44	…	controller

48	...	multiplexer
50	...	video operation amplifier
52	...	A/D converter
56	...	personal computer
59	...	sorting unit
64	...	support roller
66	...	non-defectives hopper
68	...	defectives hopper

第 1 図



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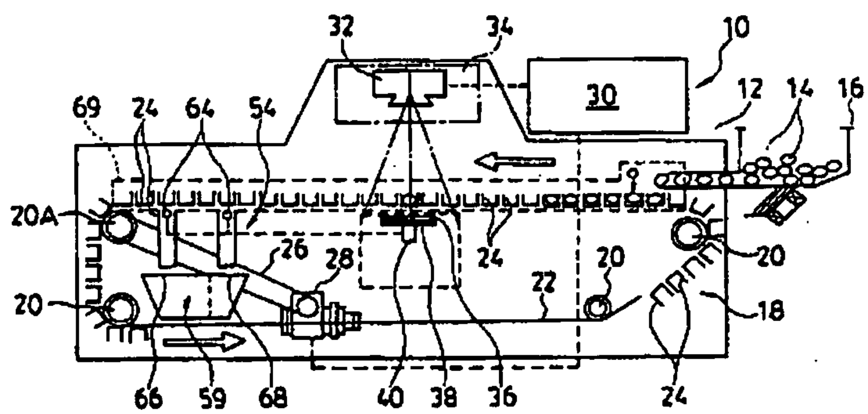

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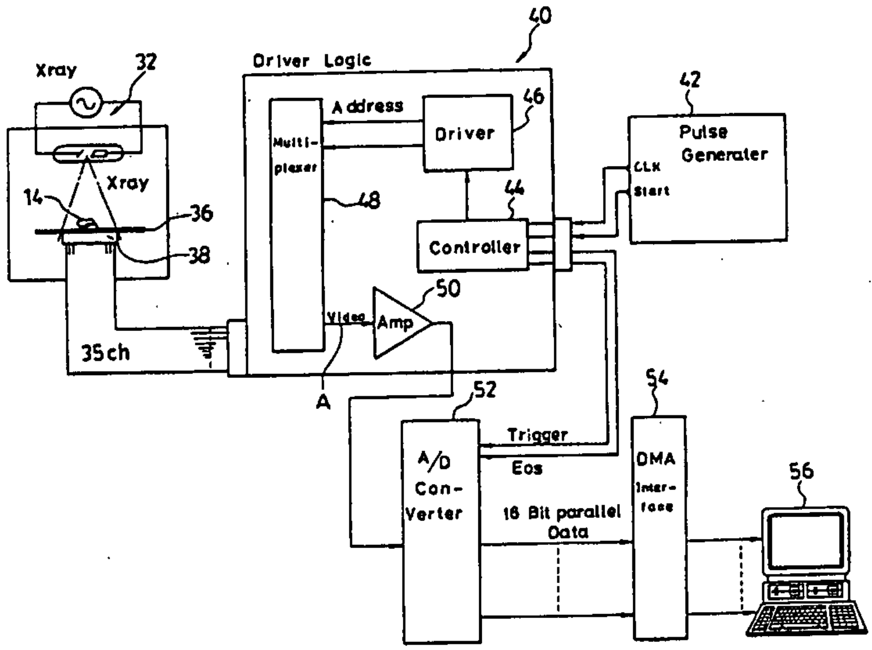

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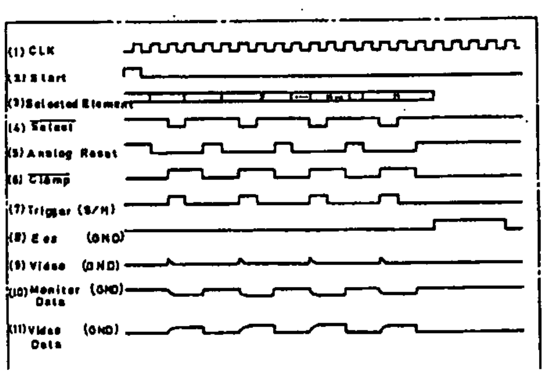

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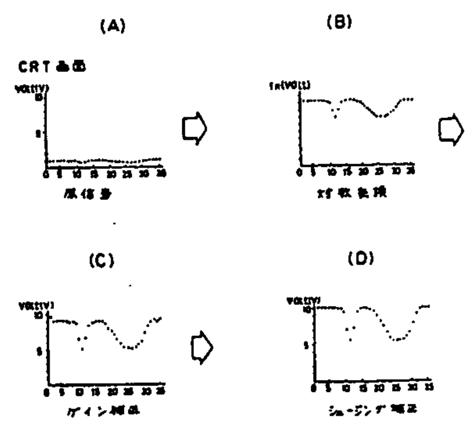

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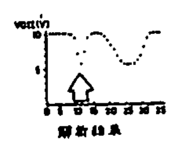


Figure 5 KEY:

(A) CRT screen

[figure]

Original signal

(B) Logarithmic transformation

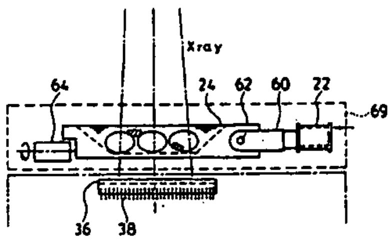
(C) Gain correction

(D) Shading correction

Figure 6 KEY:

Analytic result

第7図



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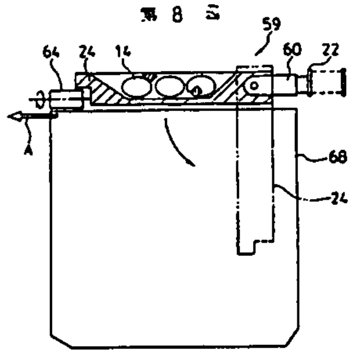

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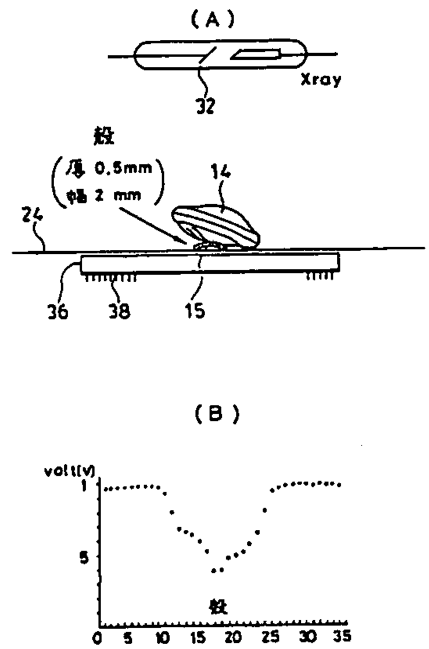

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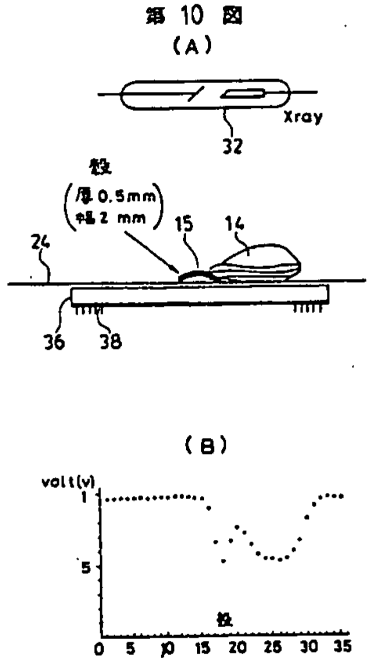

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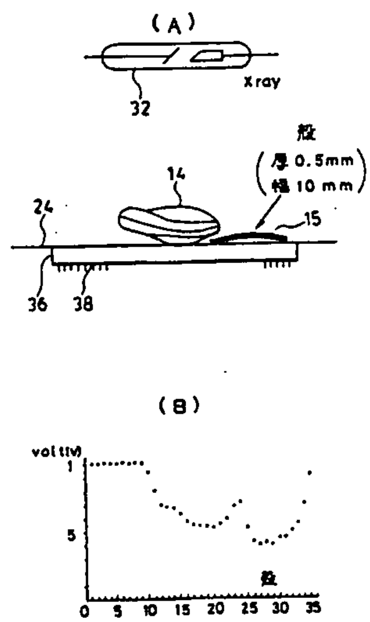


Figure 9 KEY:

shell

(thickness 0.5 mm

width 2 mm)

Figure 10 KEY:

(A)

shell

(thickness 0.5 mm

width 2 mm)

(B)

shell

Figure 11 KEY:

(A)

shell

(thickness 0.5 mm

width 2 mm)

(B) shell

Figure 12 KEY:

(A)

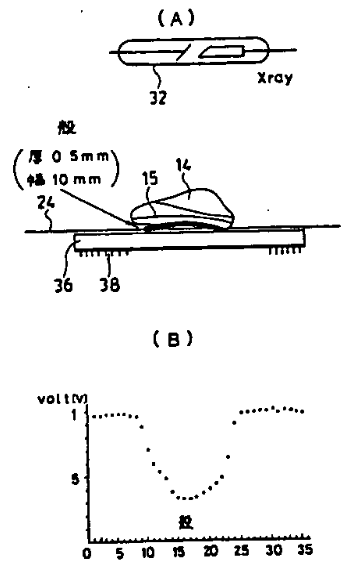
shell

(thickness 0.5 mm

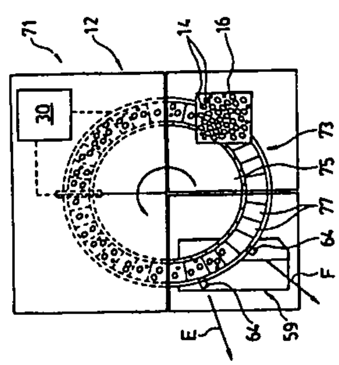
width 2 mm)

(B) shell

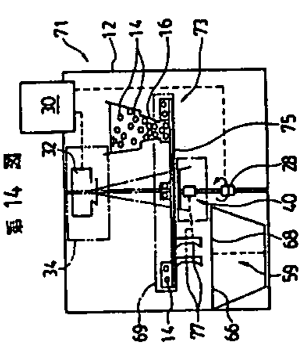
第 12 図



第 13 図



第 14 図



第 15 図